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A NEW GINGER DISEASE IN GODAVARI DISTRICT

BY

S. SUNDARARAMAN, M.A.

Government Mycologist, Madras

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A NEW GINGER DISEASE IN GODAVARI DISTRICT.

BY

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Government Mycologist, Madras.

[Received for publication on 10th February, 1922.]

DURING the month of November 1920, the writer's attention was first called to this disease at Modekurru in Godavari District. The village was visited and the crop examined. It was reported that the two previous crops had suffered considerable loss. It was difficult to estimate at that time how serious the disease might prove to be. In a letter one of the garden owners stated that more than 75 per cent. of the plants were found affected by the disease.

In this village and other villages in the neighbourhood ginger occupies an important place in cultivation. In almost all high level lands, every ryot grows it in small plots. It is sometimes irrigated from wells. The land is well prepared and manuring by sheep-penning is common. The rhizomes are planted in June and sometimes in the first week of July and the crop is ready for harvest from January to March. The plants occupy the ridges and are 5 to 6 inches apart in lines 1 to $1\frac{1}{2}$ feet apart. When full grown the crop presents a very luxuriant appearance. It is always grown pure. In its early stages it is protected by shade. The crop under shade always looks better and the rhizomes are reported to grow bigger. Sometimes ginger is found cultivated in the midst of coconuts. In good garden lands it is raised year after year without any rotation. In this case the only preliminary treatment the land receives is crow-barring in February and subsequent levelling in June. Often the seeds are planted close, the crop is thick and there is little penetration of light and air—conditions which favour disease when bad weather supervenes. In this district the average yield from a ten-cent plot is 4 *putties* or

2,000 lb. green ginger. The price varies from Re. 1-8 to Rs. 5 per 25 lb. The crop is thus very profitable and any disease involves much loss to the cultivator.

During the year 1920, the rainfall in August and September was very heavy, much heavier than in normal years. The disease made its appearance in August and gradually spread and grew in virulence. High humidity seemed to help the spread and progress of the disease. A few yards away from this plot there were larger areas under turmeric, which showed a severe form of leaf-spot disease caused by the fungus *Vermicularia Curcumæ*. Leaves and leaf-sheaths were so badly attacked that they got dried up, with the result that few rhizomes were formed. A few ryots attributed the disease to the manure used. A few others blamed the north winds blowing at that time. From fuller enquiries, it was clear that the disease appeared in August and gradually spread from north to south, the direction in which the wind was blowing. The disease made very rapid progress during the period of continued wet weather. A change of weather condition arrested the progress of the disease and many plants appear to have recovered.

Description of the disease.

Leaves were the first to show disease symptoms. Light yellow spots both on the upper and lower surfaces were a sure sign. These were at first small, round and oval, 2-3 mm. in diameter (Plate I, fig. 1). They gradually increased in size. Later, some of them coalesced together to form large discoloured patches, and tiny black dots appeared in the centre. The tissues in the centre dried up and holes were formed. If the open leaf gets the disease, it rots and dries up (Plate I, figs. 2 & 3). The leaf-sheath and the scaly portion of the rhizomes do not escape it. In the final stages, minute dark dots appear in irregular concentric rings in the diseased region (Plate II, fig. 1). These dots consist of a stroma, with large clusters of hyphæ and masses of spores and setæ. The setæ can be seen with the help of a hand-lens (Plate II, fig. 2). When the central shoots are affected the entire surface is studded with these spots (Plate I, figs. 2 & 3). These show the fructification of the fungus. When several spots appear on the edges of the leaf, the edges roll up (Plate I, fig. 1). When the leaf-tip is affected it bends and droops down. The intensity of the disease is seen in the petioles and the scaly leaf on the rhizomes being affected. In a few instances, the lower leaves of plants show the disease while the top leaves look healthy. In certain cases the central shoot is affected and the lower leaf is free. Thus, the crop exhibits various symptoms pointing to the conclusion that these are cases of local

DISEASED GINGER PLANTS.

1, Disease spots on leaves; 2, Drying up of leaves from tips; 3, Central shoot withering. Spore pustules of the fungus are shown on diseased parts.

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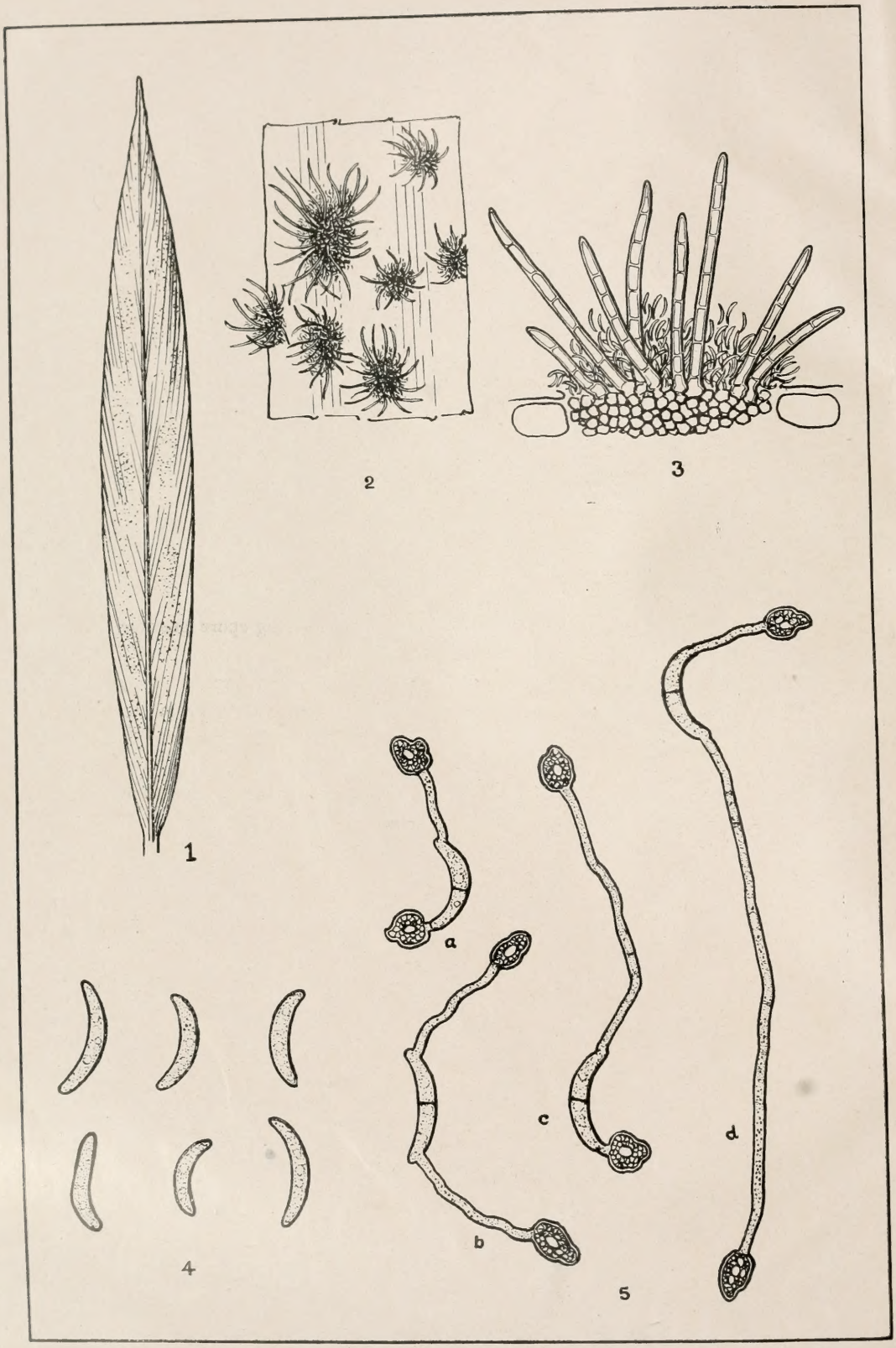


A NEW GINGER DISEASE.

EXPLANATION OF PLATE II.

1. Leaf with minute black dots. (Natural size).
2. Minute black dots magnified under low power, showing spore pustules and setæ of *Vermicularia*. ×82 μ.
3. A single pustule as seen under high power of the microscope, showing dark brown septate setæ and masses of falcate spores, × 360 μ.
4. Spores falcate-single-celled guttulate with fine granular contents. × 880μ.
5. Spores showing several stages of germination forming thick-walled dark brown chlamydospores. × 880μ.

infection—infection from plant to plant favoured by conditions of moisture and atmosphere, that is, rainy weather followed by wind and moist muggy weather. The disease appears in August and seems epidemic in years of heavy rainfall. Continued rain with spells of dry weather is congenial for its development. The rains wash down the fungus spores to lower portions of the plant, and the wind carries the spores from leaf to leaf and from plant to plant. The cultivator produces conditions favourable to the disease by his thick planting which tends to make plants touch each other, not admitting light and air which are essential for healthy vigorous growth.

Effects of the disease.

The disease appears on the leaves. This is the part where the plants manufacture food. The disease makes its appearance in the growing period of the crop and at a time when the rhizomes begin to develop. As the fungus attacks directly the place where plant food is manufactured, the plants get stunted and the rhizomes do not develop. Under healthy conditions the crop stands in the ground from July to March but when the disease comes on, the crop has often to be lifted early before the plants begin to die.

Description of the fungus.

The sporodochia appear in pale yellow spots varying in size. They are aggregated together in dense clusters, circular to oval in outline, black in colour, 50-140 μ in diameter (Plate I, fig. 1) ; setæ numerous, erect, dark brown, septate, 85-168 μ long (Plate II, figs. 2 & 3) ; spores, subfusoid, curved with a blunt point, hyaline, minutely guttulate, 17·5-24 $\mu \times$ 3·15-4·2 μ (Plate II, fig. 4). On leaves, petioles and scale-like leaves on the rhizomes of ginger in Amalapur Taluk, Godavari District.

The hyphæ are hyaline and septate. They vary in diameter from 2 to 8μ. In old culture the hyphæ become light brown. The spore clusters are formed partially submerged under the epidermis but on breaking the epidermis come out to the surface, and take on the character of *Colletotrichum*, the setæ appearing to spring from the layer of sporophore (Plate II, fig. 3). The spores germinate in 4-6 hours, putting forth a germ-tube, and produce chlamydospores in 18 hours. These are formed at the end of germ-tubes (Plate II, fig. 5, a, b, c, d). Some spores form chlamydospores without the intervention of the germ-tube. The chlamydospores are sometimes divided into cells each having a germ-pore. These are either round or ovate or irregularly lobed and are generally dark-olive. When the spores begin to germinate they produce a

septum in the centre. Sometimes the top-cell of a seta produces a hyaline hypha which bears a cluster of spores at its end.

A comparative study of different characters of Vermicularia *on ginger, turmeric and chillies.*

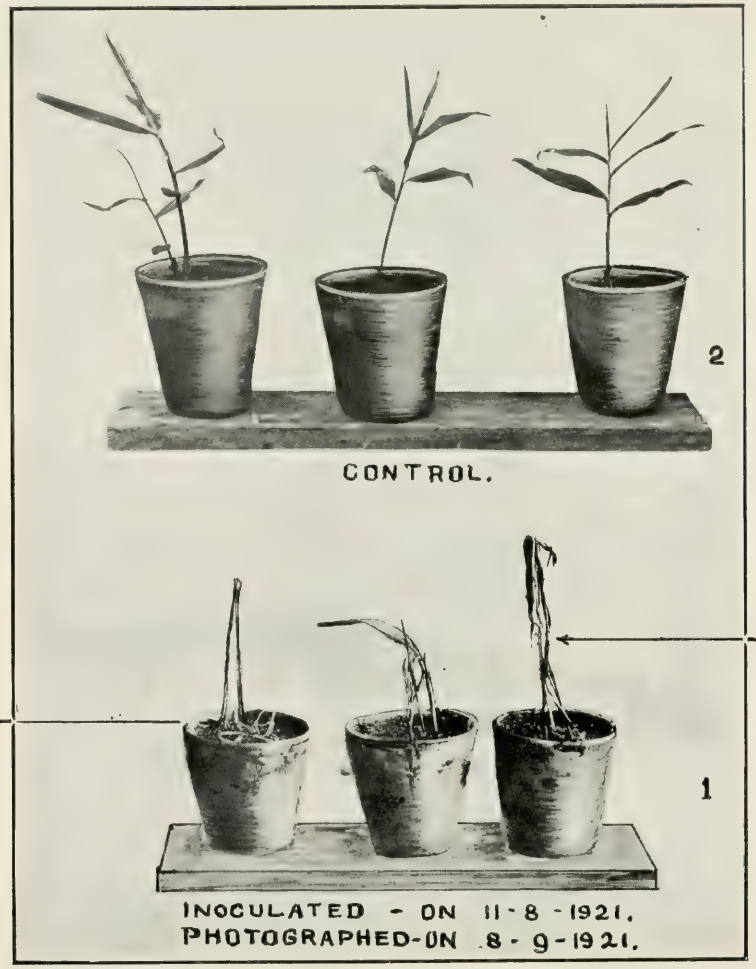
Crop	Spore pustules	Setæ	Spores
Ginger	50 to 140 μ dia.	87·5 to 168 μ	17–24 × 3–4 μ
Chillies	70 to 120 μ ,,	70 to 145 μ	17–28 × 3–4 μ
Turmeric	35 to 160 μ ,,	56 to 102 μ	19–27 × 3–5 μ

It can be seen from the above tabular statement that there is a good deal of similarity among the ginger, chillies and turmeric *Vermicularia* in point of spore measurements. But in the measurement of spore pustules and in the formation of chlamydospores there is difference. Observing the morphological similarity of the spores of ginger *Vermicularia* to *Vermicularia* on chillies and turmeric upon which the author is now working, several cross-inoculations were carried out, but with negative results. Hence the name *Vermicularia Zingiberæ* nov. sp. is suggested.

Isolation of the fungus in culture.

The fungus was brought into culture. The materials for getting this into culture were taken directly from the diseased portion of the plants. Bits of leaves showing spore formation were cut out with a pair of sterile scissors and put in melted agar tubes and transferred by the ordinary poured plate method to Petri dishes. The following day the platings were examined and single germinating spores were picked out by sterile platinum scoop and transferred to French bean and oat agar tubes. It was found that, for growth and sporulation, French bean agar furnished an excellent medium. Consequently, this was used for cultural work. The fungus grew very vigorously in French bean and oat juice agar. In 4 or 5 days dark-coloured pycnidia were formed on the surface of the agar slopes. Small, light rose-coloured droplets of thick glistening sticky fluid were seen on the surface. This was found to consist of a mass of spores.

A GINGER PLANT SHOWING EFFECT OF INOCULATION.



1, Ginger plants showing effects of inoculation ; 2, healthy controls.

PLATE IV.

Inoculations.

Ginger plants for this experiment were raised from rhizomes obtained from a disease-free locality in Malabar, dipped in 2 per cent. formalin (*i.e.*, Schering's formalin diluted) for half an hour and then washed with distilled water. The pots used for growing the plants were new and were immersed in a 0·1 per cent. solution of corrosive sublimate and dried. The soil that was put in the pot was sterilized by heating over a fire in tin pans. Before inoculation, leaves of the plants were moistened with distilled water and spores were placed on the surface. All the plants were kept under bell-jars on platforms, and were sprayed with distilled water now and then. The plants were always in a moist atmosphere. Nine plants were used for the experiment. Six were inoculated and three were kept as control, and the same treatment was given to all. At the end of four days, discoloured spots appeared on the inoculated portion. The spots varied in size from tiny flecks to 3 mm. in diameter. Later on, the leaves began to lose colour and gradually rotting set in. Plate III shows the results of inoculation. The leaves had become rotten and dried up and pustules of the fungus appeared in large numbers. The controls remained healthy. Photographs were taken 27 days after inoculation. A glance at these will show clearly the effect of the inoculation (Plate IV, fig. 1). Every inoculation was successful and in no case did any control show any disease (Plate IV, fig. 2). These data go to establish the parasitism of the fungus beyond any doubt. Infection appears to take place through the stomata and other openings in the epidermis. Pustules are of rare occurrence upon leaves while still attached to the plants. The general development of pustules takes place upon the dead and decaying leaves and is very common in diseased fields. Inoculations conducted under drier conditions gave only negative results. The following table shows the details of the inoculations.

TABLE

Ginger plants inoculated with

Serial No.	Source of culture	Where inoculated	When inoculated	4 days after inoculation	6 days after inoculation	8 days after inoculation
1	Ginger *Vermicularia* culture got from diseased ginger leaves collected at Modekurru, sub-culture (French bean agar) of 18-7-1921 used.	Upper surface of the leaves.	11-8-1921	Colour of the inoculated leaves changing. Pale yellow spots here and there noticed.	Colour of the inoculated leaves becoming pale yellow.	Inoculated leaves yellow in colour and transparent.
2		do.	do.	do.	do.	do.
3		do.	do.	do.	do.	do.
4		Lower surface of the leaves.	do.	do.	do.	do.
5		do.	do.	No change.	Colour of leaves yellow.	do.
6		do.	do.	Colour of the inoculated leaves changing yellow.	do.	do.
7		Control	do.	Healthy	Healthy	Healthy
8		do.	do.	do.	do.	do.
9		do.	do.	do.	do.	do.

All the plants were kept under bell-jars on platforms. The platforms and the plants were sprayed

Ginger plants inoculated with

1	Ginger *Vermicularia* culture got from diseased ginger leaves collected at Modekurru, sub-culture (French bean agar) of 18-7-1921 used.	Upper surface of the leaves	11-8-1921	No change	No signs of infection.	No signs of infection.
2		do.	do.	do.	do.	Plant healthy
3		do.	do.	do.	do.	do
4		Lower surface of the leaves.	do.	do.	do.	do.
5		do.	do.	do.	do.	do.
6		do.	do.	do.	do.	do.
7		Control	do.	Healthy	Healthy	Healthy
8		do.	do.	do.	do.	do.
9		do.	do.	do.	do.	do.

All the plants were kept in big glass cases specially made for inoculation purposes. The plants were as in the previous experiment.

I.

Ginger Vermicularia (*moist conditions*).

10 days after inoculation	15 days after inoculation	20 days after inoculation	30 days after inoculation	45 days after inoculation
Tiny black dots here and there on the leaves.	Dark pycnidia developing.	Fully developed pycnidia.	Pustules fully developed with setæ. Leaves beginning to rot. Suckers coming up.	Original plant dead and fallen down. Suckers getting infected with the disease.
No change	do	Pycnidia developing.	do.	do.
do.	do.	do.	do.	do.
Tiny black dots on the leaves.	do.	do.	One sucker.	do.
No change.	Tiny black pycnidia.	do.	do.	do.
do.	do.	do.	do.	do.
Healthy	Healthy	Healthy	Healthy	Healthy
do.	do.	do.	do.	Died on account of insect bite.
do.	do.	do.	do.	Healthy

with distilled water now and then and so the plants were in a very moist atmosphere.

Ginger Vermicularia (*dry conditions*).

No change	Plant healthy	No change	No infection	No infection
do.	do.	do.	do.	do.
do.	do.	do.	do.	do.
do.	do.	do.	do.	do
do.	do.	do.	do.	do.
do.	do.	do.	do.	do.
Healthy	Healthy	Healthy	Healthy	Healthy
do.	do.	do.	do.	do.
do	do.	do.	do.	do.

sprayed with distilled water thrice a day. The atmosphere inside the glass cases was not so humid

Spraying experiments to determine the efficacy of spraying with Bordeaux mixture.

In Modekurru, Amalapur Taluk, where the ginger crop was affected by this disease, a plot of 10 cents was selected for trying the efficacy of spraying with Bordeaux mixture (5-5-50 strength) in checking the disease. The first spraying was given when the disease was fairly distributed on the plants and the second after an interval of six weeks. Before spraying, all the badly affected leaves and shoots were cut out and burnt. The following statement shows the yield and other details of the sprayed plot :—

Area of sprayed plot	No. of sprayings given	Yield		Remarks
		During the year sprayed	Previous year	
10 cents.	2 at an interval of 6 weeks.	Md. $7\frac{1}{4}$	Md. $1\frac{3}{8}$	On account of spraying there is a clear gain of $5\frac{7}{8}$ maunds over the previous year.

Thus from a ten cent plot there is a gain in money value of about Rs. 16 which works out at Rs. 160 per acre.

Local practice for checking the disease.

In certain plantations of this locality the usual practice to control this disease is to sprinkle quicklime on the affected plants. Enquiries show that this dusting with quicklime is imperfect and only partially prevents its spread.

Summary.

1. The leaf disease of ginger (*Zingiber officinale*) is caused by the fungus of the genus *Vermicularia* and has been reported from Amalapur Taluk, Godavari District.

2. The disease shows itself to begin with as small yellowish spots. Later on, the whole leaf turns yellow and rots, resulting in the poor development of rhizomes causing considerable loss to the ginger growers.

3. This disease makes rapid progress during a period of continued wet weather and high humidity. A change into drier conditions checks the progress of the disease and many plants recover. The results of the inoculations in the laboratory confirm this field observation.

4. The parasitism of this *Vermicularia* is definitely proved by repeated inoculations. Under moist conditions, inside bell-jars, the plants took the infection and showed disease symptoms in 15 days. But under drier conditions the fungus failed to infect the plants. The results of the inoculations confirm the field observation that the fungus made rapid progress during continued wet weather and high humidity.

5. This *Vermicularia* on ginger inoculated on chillies and turmeric failed to produce any infection.

6. The name *Vermicularia Zingibereæ* nov. sp. is suggested, owing to (*a*) the difference in the measurements of sporodochia between *Vermicularia* on ginger, turmeric and chillies, (*b*) the character of the chlamydospores and (*c*) the negative results in the cross-inoculations on chillies and turmeric.

My thanks are due to my assistants Messrs. C. Krishnan Nair and C. S. Gopalaswami Rao for their ready help.

As this paper was completed, a *Vermicularia* was noticed on Knol-Khol (*Brassica oleracea* var. *botrytis*) and cabbage (*Brassica oleracea* var. *capitata*) in the Botanic Garden, Coimbatore. This fungus is under study.

A comparative study of the *Vermicularias* on several hosts will form the subject of a separate paper.

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